**Emerging and Re-emerging Infectious Diseases** Dr Jitendra

* Definition
* Why focus on emerging infectious diseases
* List of emerging infectious diseases
* Examples of emerging & re-emerging infectious diseases in the SEAR
* Factors responsible for emerging infectious diseases
* Economic impact
* Combating emerging infectious diseases
* Preparedness at international level
* Preparedness in India
* Preventing infectious diseases- more to do

**Definition:**

*Emerging infectious diseases* are those where the incidence in humans has either increased during the last 20 years or threatens to increase in the near future. This group of diseases also includes those identified for the first time and old ones spreading to new geographical areas. It also refers to those diseases which were previously easily treated with antibiotics but have now developed resistance to drugs.

*Re-emerging infectious diseases* are those that have increased after a significant decline in their incidence.

**Why focus on emerging infectious diseases:**

Despite remarkable advances in medical research and treatment during 20th century, infectious diseases remain among the leading causes of death worldwide for three reasons-

1. Emergence of new infectious diseases
2. Re-emergence of old infectious diseases
3. Persistence of intractable infectious diseases

It is estimated that over the last 20 years, over 30 new and highly infectious diseases have been identified. Unfortunately, many of these diseases do not yet have any cure. These diseases are the leading cause of death worldwide. These infectious diseases pose a great strain on the already stretched health services. These also add to the socio-economic burden on families and individuals. Thereby, in 1997 the World Health Day theme was "Emerging Infectious Diseases: Global Alert, Global Response". This theme clearly stressed the need for all countries to strengthen efforts to successfully prevent and control infectious diseases.

**List of emerging infectious diseases identified in the last 35 years:**

|  |  |  |  |
| --- | --- | --- | --- |
| 1973 | Rotavirus- Enteritis/Diarrhea | 1993 | Sin Nombre virus- Hanta Pulm. Synd(Aus) |
| 1976 | Cryptosporidium- Enteritis/Diarrhea | 1994 | Sabia virus- VHF |
| 1977 | Ebola virus- VHF | 1994 | Hendra virus- Respiratory ds |
| 1977 | Legionella- Legionnaire’s ds. | 1995 | Hepatitis G- Hepatitis |
| 1977 | Hantan virus- VHF w/ renal flr | 1995 | H Herpesvirus-8- Kaposi sarcoma |
| 1977 | Campylobacter- Enteritis/Diarrhea | 1996 | vCJD prion- Variant CJD(UK) |
| 1980 | HTLV-1- Lymphoma | 1997 | Avianinfluenza(H5N1)- Influenza(Hong Kong) |
| 1981 | Toxin prod. S.aureus- TSS | 1999 | Nipah virus- Encephalitis |
| 1982 | E.coli 0157:H7- HUS | 1999 | West Nile virus- Encephalitis(USA, Argentina) |
| 1982 | HTLV-II- Leukemia | 2001 | BT Bacillus anthracis-Anthrax(USA) |
| 1982 | Borrelia burgdorferi- Lyme disease | 2003 | Monkeypox- Pox |
| 1983 | HIV- AIDS | 2003 | SARS-CoV- SARS(SEA, Canada) |
| 1983 | Helicobacter pylori- Peptic ulcer ds | 2004 | H5N1- Avian Influenza(SEA) |
| 1988 | Hepatitis E- Hepatitis | 05-08 | 2005/8-AI H5N1 (Asia, Europa and África) |
| 1989 | Hepatitis C- Hepatitis | 2009 | Influenza A(N1H1)- Swine flu |
| 1990 | Guanarito virus- VHF |  |  |
| 1991 | Encephalitozoon- Disseminated ds |  |  |
| 1992 | Vibrio cholerae O139- Cholera |  |  |
| 1992 | Bartonella henselae- Cat scratch ds |  |  |

**Examples of emerging & re-emerging infectious diseases in the South-East Asia Region**:

Emerging diseases include HIV/AIDS, cholera, tuberculosis, malaria, dengue hemorrhagic fever, viral hepatitis, meningitis and Japanese encephalitis.

Re-emerging infectious diseases are plague and kala-azar.

There are also some infectious diseases that have occurred in other parts of the world but have the potential to appear in the Region; for example, Hanta virus, and yellow fever and Ebola hemorrhagic fever.

**List of NIAID Emerging and Re-emerging Diseases:**

**Group III—Agents with Bioterrorism Potential**

**NIAID—Category B**

* Burkholderia pseudomallei
* Coxiella burnetii (Q fever)
* Brucella species (brucellosis)
* Burkholderia mallei (glanders)
* Chlamydia psittaci (Psittacosis)
* Ricin toxin (from Ricinus communis)
* Epsilon toxin of Clostridium perfringens
* Staphylococcus enterotoxin B
* Typhus fever (Rickettsia prowazekii)
* Food- and waterborne pathogens
  + Bacteria
    - Diarrheagenic E.coli
    - Pathogenic Vibrios
    - Shigella species
    - Salmonella
    - Listeria monocytogenes
    - Campylobacter jejuni
    - Yersinia enterocolitica)
  + Viruses (Caliciviruses, Hepatitis A)
  + Protozoa
    - Cryptosporidium parvum
    - Cyclospora cayatanensis
    - Giardia lamblia
    - Entamoeba histolytica
    - Toxoplasma
  + Fungi
    - Microsporidia
* Additional viral encephalitides
  + West Nile virus
  + LaCrosse
  + California encephalitis
  + VEE
  + EEE
  + WEE
  + Japanese Encephalitis virus
  + Kyasanur Forest virus

**NIAID—Category C**

Emerging infectious disease threats such as Nipah virus and additional hantaviruses.

**Group I—Pathogens Newly Recognized in the Past Two Decades**

Acanthamebiasis  
Australian bat lyssavirus  
Babesia, atypical  
Bartonella henselae  
Ehrlichiosis  
Encephalitozoon cuniculi  
Encephalitozoon hellem  
Enterocytozoon bieneusi  
Helicobacter pylori  
Hendra or equine morbilli virus  
Hepatitis C  
Hepatitis E  
Human herpesvirus 8  
Human herpesvirus 6  
Lyme borreliosis  
Parvovirus B19

**Group II—Re-emerging Pathogens**

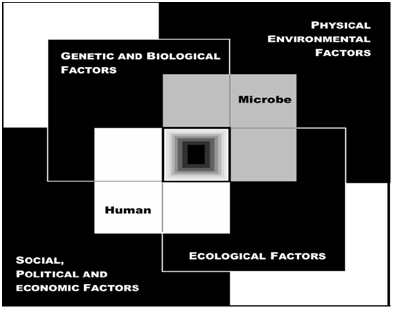
Enterovirus 71  
Clostridium difficile  
Mumps virus  
Streptococcus, Group A  
Staphylococcus aureus

**Group III—Agents with Bioterrorism Potential**

**NIAID—Category A**

* Bacillus anthracis (anthrax)
* Clostridium botulinum toxin (botulism)
* Yersinia pestis (plague)
* Variola major (smallpox) and other related pox viruses
* Francisella tularensis (tularemia)
* Viral hemorrhagic fevers
  + Arenaviruses
    - LCM, Junin virus, Machupo virus, Guanarito virus
    - Lassa Fever
  + Bunyaviruses
    - Hantaviruses
    - Rift Valley Fever
  + Flaviruses
    - Dengue
  + Filoviruses
    - Ebola
* Marburg

**Factors responsible for emerging infectious diseases:**



**The Convergence Model:** At the center of the model is a box representing the convergence of factors leading to the emergence of an infectious disease. The interior of the box is a gradient flowing from white to black; the white outer edges represent what is known about the factors in emergence, and the black center represents the unknown (similar to the theoretical construct of the “black box” with its unknown constituents and means of operation). Interlocking with the center box are the two focal players in a microbial threat to health—the human and the microbe. The microbe– host interaction is influenced by the interlocking do-mains of the determinants of the emergence of infection: genetic and biological factors; physical environmental factors; ecological factors; and social, political, and economic factors.

Thirteen individual factors—some reflecting the ways of nature, most of them reflecting our ways of life—account for new or enhanced microbial threats. Any of these factors alone can trigger problems, but their convergence creates especially high-risk environments where infectious diseases may readily emerge, or re-emerge, affecting the world & posing particular challenges for the medical and public health communities.

1. Human demographics and behavior
2. Technology and industry
3. Economic development and land use
4. International travel and commerce
5. Microbial adaptation and change
6. Breakdown of public health measures
7. Human vulnerability
8. Climate and weather
9. Changing ecosystems
10. Poverty and social inequality
11. War and famine
12. Lack of political will
13. Intent to harm
14. **Demographic factors and behavior:** Infectious diseases can result from individual’s activities that involve exposure to microbial pathogens or simply from the increased probability of infectious disease as population grow and people come into closer contact. High population density carries increased potential for spread of person-to-person disease, greater likelihood of global warming, large number of travelers, increased hunger and malnutrition. Societal events: Population growth and migration (movement from rural areas to cities); war or civil conflict; urbanization; sexual behavior, intravenous drug use; use of high-density facilities
15. **Technology and Industry:** Advances in medical technologies (blood transfusions and organ & tissue transplants), globalization of food supplies; changes in food processing and packaging; have created new pathways for the spread of certain infections. Drugs causing immune-suppression make people susceptible for infection; widespread use of antibiotics cause emergence of drug resistance diseases.
16. **Ecological changes (including those due to economic development and land use):** New or previously unknown infectious diseases have emerged from the increased human contact with animal reservoirs that resulted from changing land-use patterns e.g. Agriculture, dams, deforestation/reforestation, flood/drought, famine, climate changes etc. Malaria, dengue fever and schistosomiasis have increased in areas wherever artificial water bodies have been created. Clearance of forests to build an international airport in Malaysia in the 1990s led to a devastating outbreak of Nipah virus, carried by forest bats fleeing to agricultural lands.
17. **International travel and commerce:** The rapid and virtually unrestricted transport of humans, animals, foods, and other goods lead to the broad dissemination of pathogens and their vectors throughout the world e.g. SARS has been documented to be the one of the fastest moving microorganisms in the history of mankind(SARS was carried through international air travel by infected people to 31 countries that reported probable cases of SARS), the Spanish influenza traveled around the world in less than 12 months, Hong Kong (1968-69) influenza took only six months and a future pandemic is likely to spread more rapidly because of the speed and frequency of human travel. Emerging infections can arise from animals and birds (e.g. chickens and H5N1) and seed a pandemic through movements to distant countries through seasonal migrations or trade.
18. **Microbial Adaptation and Change:** The tremendous evolutionary potential of mi­crobes makes them adept at developing resistance to even the most potent drug therapies and vaccines.
19. **Breakdown of Public Health Measures:** In many places, the lack of basics such as potable water or sanitation contributes to infectious diseases. But similar effects can also occur from inadequate prevention programs (vaccine supplies, low immunization rates); inadequate sanitation and vector control measures. A well functioning public health infrastructure can prevent many infections, particularly those that are food-borne or water-borne. Defects in the health system can result in massive epidemics. An efficient public health system not only quickly detects and responds to the epidemic during its initial phase but is also sensitive enough to spot a new or unidentified infection. Almost all the outbreaks of hepatitis E in India have been traced to the piped water that got contaminated by sewage from the pipes carrying sewer.
20. **Human Vulnerability:** Susceptibility to infection can develop when normal defense mechanisms are impaired by causes such as genetically inherited traits and malnutrition. Susceptibility can also result from antimicrobial resistance induced by the promiscuous use of antibiotics.
21. **Climate and Weather:** Climate directly affects disease transmission through its impacts on the replication, movement, and evolution of microbes and vectors; climate also operates indirectly through its effects on ecology and human behavior. At warmer temperatures, parasites develop more rapidly in mosquitoes. Consequently, there will be an increase in the incidence of malaria and dengue fever.
22. **Changing Ecosystems:** Altered environments influence the transmission of microbial agents, whether waterborne, airborne, food borne, or vector borne.
23. **Poverty and Social Inequality:** Poverty breeds ill health and ill health, in turn, breeds poverty. Mortality from infectious diseases is closely correlated with global inequalities in income. Economic trends affect not only the individuals at risk but also the structure and availability of public health institutions necessary to reduce risks.
24. **War and Famine:** Displacement caused by war and sequelae of malnutrition from famine contribute significantly to the emergence and spread of infectious diseases.
25. **Lack of Political Will:** Governments in the regions of highest disease prevalence must commit themselves. The leaders of affluent regions that ultimately share the same global microbial landscape should also commit.
26. **Intent To Harm:** The world today is vulnerable to the threat of deliberate biological attacks that can cause large numbers of deaths and widespread social disruption. The likelihood of such events, in fact, is high, and public health systems and health care providers must be prepared to address them.

**Economic impact**

Globally 350 million DALYs that is lost due to communicable diseases & South-East Asia Region accounts for 89 million.

On an average, 2 to 2.5 million cases of malaria are reported annually with an estimated 27,000 deaths and an annual economic loss of US$ 2 billion.

Tuberculosis continues to be the biggest killer of young adults. Multidrug resistant-TB is at least 100 times more expensive to cure.

The 1994 locally-contained outbreak of plague in India (Surat), estimated to cost US$2 billion.

Estimates on the cost of the SARS outbreak range from US$10 billion to US$30 billion.



The 1997 avian influenza in Hong Kong which is estimated to have cost hundreds of millions of dollars lost in poultry production, commerce and tourism. It is difficult to measure the social and psychological impact of these outbreaks.

**Combating emerging infectious diseases:**

There are five strategic elements that are needed to combat emerging diseases. These include:

1. **Epidemic preparedness and rapid response:**

Surveillance in its simplest form is collection of information for action. A disease or an event under surveillance is first picked up by the health care system which reports it to the public health authority for interpretation and initiating action as shown below in conceptual framework for the surveillance and response system for emerging infectious diseases. However, in many developing countries implementation of this framework is hampered by several deficiencies like

* Inadequacies in data collection
* Incapability of analysis of data by health care workers
* Weak feedback mechanism
* Inadequate public health laboratory support system

Implementation of a national plan requires -

* Strengthening of capacity
* Development of infrastructure
* Availability of qualified and trained human resource

*Objectives:*

* *Strengthening of routine in-country surveillance for emerging infectious diseases*
* *Enhance detection of outbreaks by the development of early warning systems*
* *Forging strong surveillance networks to facilitate flow of information and initiation of appropriate action.*

Fig: Conceptual framework for surveillance & response of emerging infectious diseases

Health care system

Public health laboratory

Event

Intervention

Reporting

Data

Information

Analysis & Interpretation

Decision

(Feedback)

1. **Public health infrastructure:**

Public health infrastructure is the backbone of any efficient public health activity. It consists of people who work in the field of public health, epidemiology, entomology, environmental hygiene, infection control, laboratories and information and communication specialists at district, state and national levels.

Fig: Public health infrastructure

The institutions, human resource, equipment and technologies as well as quality assurance of the activities should be developed and strengthened in such a way that all contribute efficiently to achieve the objectives of combating emerging infectious diseases. These include public health laboratories for identification and molecular characterization of causative agents, development, appropriate use, and availability of diagnostic tests and reagents; cooperation from informed communities, use of modern communication and information technology.

**Multisectoral involvement** isneeded for effective control of infectious diseases like national authorities in different sectors namely private sector, academic institutes, the mass media, NGOs and various international developmental partners. An enhanced public and private mix is needed to provide services to manage emerging infectious diseases.

**Human resource**- There is amajor shortage of qualified and trained public health staff. Each country must ensure an adequate number of qualified, competent and trained professionals of different fields like epidemiology, entomology, public health laboratories, information technology and communication. Accurate and timely laboratory analysis is critical for identifying, tracking and limiting public health threats.

Similarly, emerging disease surveillance should utilize modern computing and communication technologies to transform data into useable information quickly and effectively. Accurate and efficient data transfer with rapid notification of key partners and constituents is critical to effectively address the threats of emerging diseases. A network of public health laboratories should be created with strong linkages between various laboratories.

**Information sharing and networking**-International surveillance and response networks enable countries to be better prepared and respond to epidemics as was seen during the SARS outbreak.

1. **Risk communication:**

Risk communication is an interactive process of exchanging information and opinion among individuals, groups and institutions. Risk communication targets the general public as well as the mass media, the latter to facilitate wide dissemination of appropriate messages so that it delivers messages that inform without frightening and educate without alarming.

The objectives of risk communication are

* To ease public concern by informing them about the risk, the treatment, the transmission dynamics and clinical features of disease outbreak
* To make the public aware of actions that need to be initiated by people themselves for their benefit as well as for cutting short the transmission of infection.

1. **Research and its utilization:**

Research can play an important role during an outbreak, in identifying the etiological agent, developing diagnostic tools, case management modules and preventive strategies.

(a) *environmental factors* which facilitate the emergence, maintenance and transmission of these diseases, especially vector-borne and zoonotic infections. These factors mainly include deforestation, developmental projects, global warming, urban ecology, dynamics of transmission between wild and domestic animals.

(b) *evolution of pathogenic infectious agents* resulting in changes in infectivity, virulence, transmissibility and adaptations based upon identification of changes at molecular level especially the genetic composition of the organisms

(c) *host factors* that facilitate the emergence of infections and their spread including the use of antimicrobial and immunosuppressant drugs and the protective factors in a host

(d) *Development of new diagnostic tools* that support rapid and accurate diagnosis even in field conditions

(e) *Social inequalities and behavioral factors* that influence distribution of emerging diseases, their course and the populations that are affected most

(f) *Impact of environmental changes and climatic variability on the emergence of microbes*: Scientific research is also needed to guide public policy; develop evidence-based policies for rational use of antimicrobial agents in humans, animals and the environment and the formulation of environment-friendly and safe insecticides and pesticides.

1. **Advocacy for political commitment and partnership building:**

Prevention and control of emerging infectious diseases is the responsibility of national governments. This cannot be delegated to any other agency or organization. At the same time, efficient program management can be implemented only if there is a strong political will and commitment, adequate financial and human resources as well as productive partnerships with different sectors. The goal can be achieved through a strong infrastructure, competent and skilled human resources and an efficient intersectoral partnership. The collaboration between government agencies is easier and feasible. It becomes challenging when the private sector and the mass media are to be involved. The mass media and private sector has extensive reach to community. Both are critical partners. A national plan for emerging infectious diseases should be developed and a National Technical Advisory Group established to guide, advise and monitor the national efforts against emerging infectious diseases. A national focal point should be identified to coordinate with various sectors.

**Preparedness at International level:**

WHO continues to track the evolving infectious disease situation, alert the population, share expertise, and mount the kind of response needed to protect populations from the consequences of epidemics, whatever and wherever might be their origin.

**International Health Regulation:** "IHR (2005)" have been in force since 15 June 2007. The purpose of the IHR (2005) is to prevent, protect against, control and provide a public health response to the international spread of disease. IHR restricted to public health risks. Hence there is no interference with international traffic and trade. The IHR (2005) provide a framework for WHO epidemic alert and rapid response activities.

The IHR (2005) introduces new operational concepts including:

* Specific procedures for disease surveillance, notification and reporting of public health events and risks to WHO by countries
* Requests by WHO for verification of public health events occurring within countries
* Rapid collaborative risk assessment with and assistance to countries
* Determinations as to whether an event constitutes a public health emergency of international concern
* Coordination of international response

**The Global Outbreak Alert and Response Network (GOARN):** is a technical collaboration of existing institutions and networks. It pools human and technical resources for the rapid identification, confirmation and response to outbreaks of international importance. It is an operational framework that links this expertise and skill. It keeps the international community constantly alert to the threat of outbreaks and ready to respond. The Global Outbreak Alert and Response Network contribute towards global health security by:

* Combating the international spread of outbreaks
* Ensuring that appropriate technical assistance reaches affected states rapidly
* Contributing to long-term epidemic preparedness and capacity building.

**Preparedness in India**

**IDSP (**Integrated disease surveillance project**):**

Project objectives:

* + - 1. To establish a decentralized state based system of surveillance for communicable & non-communicable diseases, so that timely & effective public health actions can be initiated in response to health challenges in the country at state & national level.
      2. To improve the efficiency of the existing surveillance activities of disease control programs & facilitate sharing of relevant information with the health administration, community and other stakeholders so as to detect disease trends over time and evaluate control strategies.

Specific objectives:

* To integrate & decentralize surveillance activities
* To establish systems for data collection, reporting, analysis and feedback using information technology
* To improve laboratory support for disease surveillance
* To develop human resources for disease surveillance and action
* To involve all stakeholders including private sector & communities in surveillance

**Administrative structure:**

National disease surveillance committee (State disease surveillance committee/ District surveillance committee)

* Secretary health/Family Welfare- Chair person(Alternate)
* DGHS(Co-chair)
* JS Health
* JS Family Welfare
* Director NICD
* Director NIB
* Representative Ministry of Home, Ministry of Environment, IMA, NGO
* National surveillance officer
* National program managers- Polio, Malaria, TB, HIV/AIDS
* Consultants (WHO, Medical college)

**Warning signs of an Impending outbreak:**

* Clustering of cases or deaths in time and/or space
* Unusual increase in cases or deaths
* Even a single case of measles, AFP, Cholera, Plague, Dengue, or JE
* Acute febrile illness of unknown etiology
* Occurrence of two or more epidemiologically linked cases of meningitis, measles
* Unusual isolates
* Shifting in age distribution of cases
* High vector density
* Natural disasters

**Investigation of an outbreak:**

Unusual Health event

Is this an outbreak?

Yes

No

Etiology, source & transmission known?

Institute control measures

Yes

No

Further investigation (clinical, Laboratory, Epidemiological)

Institute control measures

Develop hypothesis regarding source, transmission, etiology & people at risk

Describe outbreak in terms of Place, Time & Person

Does Hypothesis fit with the facts?

Yes

No

Special studies

**Response to an outbreak:**

1. Nullification of source
2. Minimizing transmission
3. Protecting the host

**Preparedness for Swine flu:**

**Series of administrative actions instituted by GOI-**

1. Surveillance at Ports & International airports
2. Integrated disease surveillance units in states alerted to report clusters of Influenza like illness & pneumonia
3. Travel advisory issued for those travelling to the affected area to deter their plan
4. Establishment of state rapid response team- Any suspected cluster of Influenza like illness needs to be investigated by State Rapid Response Team & managed in isolation facility with strict infection control practices & if needed, Central Rapid Response team assist the state
5. Central government support the state in terms of guidelines, experts, lab supports, Oseltamivir & personal protective equipments
6. Guidelines circulated to all medical colleges, infectious disease hospitals, hospitals identified with isolation facilities & district level hospitals
7. Decentralization of stock of Oseltamivir & personal protective equipments to regional offices so that state can use these in case of human cluster of Influenza like illness reported in state
8. Important contact sites

* Emergency Medical Relief (EMR) control room (Ministry of Health & Family Welfare)- working 8am to 8 pm. Ph no. 011-23061469
* Outbreak monitoring cell control room (NICD) - work for 24x7 to attend calls from public regarding reporting of influenza like illness. Ph no. 011-239221401

**Steps of Government of India to prevent outbreak in country:**

1. Early detection of cases among passengers coming from affected countries either by air , ship or road
2. Massive mass media campaign to inform & educate people on dos and don’ts
3. Sharing information with public through media
4. Appeal made by government- People who have travelled from affected countries in past 10 days & shows symptoms of Influenza should immediately contact the Ph no. as above or nearby Govt hospital

**Preventing infectious diseases- more to do:**

* Enhance communication: locally, regionally, nationally, globally
* Increase global collaboration
* Share technical expertise and resources
* Provide training and infrastructure support globally
* Ensure political support
* Ensure judicious use of antibiotics
* Vaccines for all

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